

DETAILED ACTION

EXAMINER'S AMENDMENT

1. An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it **MUST** be submitted no later than the payment of the issue fee.

Authorization for this examiner's amendment was given in a telephone interview with Angela Mae Coxé on November 13th 2009.

The application has been amended as follows:

1. (Currently Amended) A method for increasing the capability of a network topology model having a plurality of nodes connected by existing links to maintain service continuity in the presence of faults, said method comprising:

(a) adding new links to the network topology model to protect against single node failures; and

(b) adjusting link weights for the network topology model to reduce at least one of a cost of network operation, and an imbalance in link utilizations;

wherein step (a) comprises the sub-steps of:

(1) failing one of the plurality of nodes in the network topology;

(2) calculating a first number of disconnected node pairs;

(3) selecting a pair of nodes which are neighbors to the failed node;

(4) adding a new link between the pair of nodes;

(5) calculating a second number of disconnected node pairs;

(6) retaining the new link and setting the first number equal to the second number when the second number is less than the first number;

(7) repeating sub-steps (3) through (6) for randomly selected combinations of pairs of neighbor nodes until the first number equals zero;

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(8) repeating sub-steps (1) through (7) for each of the plurality of nodes in the network topology as modified by the addition of the retained links;

(9) removing one of the plurality of retained links in the modified network topology;

(10) restoring the removed link when the removal causes any node pair to become disconnected for any single node failure; and

(11) repeating sub-steps (9) through (11) for each of the plurality of retained new links in the modified network topology.

2. (Original) A method for increasing the capability of a network topology model as defined in Claim 1, wherein said adjusting link weights in step (b) is performed to reduce said imbalance in link utilizations without deteriorating said cost of network operation.

3. (Original) A method for increasing the capability of a network topology model as defined in Claim 1, wherein said adjusting link weights in step (b) is performed to reduce said cost of network operation without increasing said imbalance in link utilizations.

4. (Original) A method for increasing the capability of a network topology model as defined in Claim 1, wherein said adjusting link weights in step (b) is performed to reduce said cost of network operation without increasing said imbalance in link utilizations while keeping the utilization for each link below a specific threshold.

5. (Original) A method for increasing the capability of a network topology model as defined in Claim 1, further comprising the step of:

(c) adding links to the network topology model to reduce the cost of network operation.

6. (Cancelled)

7. (Currently Amended) A method for increasing the capability of a network topology model as defined in Claim 1, wherein said adjusting link weights for the network

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topology model to reduce the cost of network operation in step (b) comprises the sub-steps of:

- (1a) unmarking each link in the network topology;
- (2b) calculating a network cost for operating the current network topology based upon a link cost associated with said each link;
- (3e) incrementing the weight of one of said each ~~the unmarked~~ link in the current network topology having the maximum link cost to modify the network topology;
- (4d) calculating a network cost for operating the modified network topology;
- (5e) restoring the weight and marking ~~the~~ said one of said each link having the maximum link cost when the network cost for operating the modified network topology is greater than or equal to the network cost for operating the current network topology; and
- (6f) repeating sub-steps (2b) through (5e) until said each ~~of the~~ links in the network topology is marked.

8. (Currently Amended) A method for increasing the capability of a network topology model as defined in Claim 7, wherein:

said sub-step (2b) in step (b) further comprises determining survivability characteristics of the current network topology;

said sub-step (4d) in step (b) further comprises determining the survivability characteristics of the modified network topology; and

said sub-step (5e) in step (b) for restoring the weight and marking the link having the maximum link cost is performed when at least one of:

the survivability characteristics of the modified network has deteriorated in comparison to the survivability characteristics of the current network topology; and

the network cost for operating the modified network topology is greater than or equal to the network cost for operating the current network topology.

9. (Currently Amended) A method for increasing the capability of a network topology model as defined in Claim 5, wherein step (c) comprises the sub-steps of:

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- (1a) selecting a maximum number of potential links to be added to the network topology;
- (2b) selecting a maximum number of new links to be added to the network topology;
- (3e) finding a potential link that when added to the current network topology will result in a maximum reduction in the cost of network operation;
- (4d) adding the potential link to the current network topology;
- (5e) repeating sub-steps (3e) and (4d) until the maximum number of potential links have been added to the current network topology;
- (6f) finding the potential link that when removed from the current network topology will result in the lowest cost of network operation;
- (7g) removing the potential link from the current network topology;
- (8h) repeating sub-steps (6f) and (7g) until the maximum number of potential links is reduced to the maximum number of new links to be added to the network topology.

10. (Currently Amended) A method for increasing the capability of a network topology model as defined in Claim 1, wherein said adjusting link weights for the network topology model to reduce the imbalance in link utilizations in step (b) comprises the sub-steps of:

- (1a) unmarking ~~all of the~~ each links in the network topology;
- (2b) calculating a standard deviation of link utilization for the current network topology;
- (3e) incrementing the weight of one of said each ~~the unmarked~~ link in the current network topology having the maximum utilization to modify the network topology;
- (4d) calculating a standard deviation of link utilization for the modified network topology;
- (5e) restoring the weight and marking ~~the~~ said one of said each link having the maximum utilization when the standard deviation of link utilization for the current

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topology is less than the standard deviation of link utilization for the modified topology;
and

(6f) repeating sub-steps (2b) through (5e) until said each of the links in the network topology is marked.

11. (Currently Amended) A method for increasing the capability of a network topology model as defined in Claim 10, wherein:

said sub-step (2b) in step (b) further comprises determining survivability characteristics of the current network topology;

said sub-step (4d) in step (b) further comprises determining the survivability characteristics of the modified network topology; and

said sub-step (5g) in step (b) for restoring the weight and marking the link having the maximum link cost is performed when at least one of:

the survivability characteristics of the modified network has deteriorated in comparison to the survivability characteristics of the current network topology; and

the standard deviation of link utilization for the current topology is less than the standard deviation of link utilization for the modified topology.

12. (Currently Amended) A method for increasing the capability of a network topology model as defined in Claim 2, wherein step (b) comprises the sub-steps of:

(1a) calculating a network cost for operating the current network topology based upon a link cost associated with each link;

(2b) unmarking ~~all of the~~ said each links in the network topology;

(3e) calculating a standard deviation of link utilization for the current topology;

(4d) incrementing the weight of one of said each ~~the unmarked~~ link in the current network topology having the maximum utilization to modify the network topology;

(5e) calculating a network cost for operating the modified network topology;

(6f) calculating a standard deviation of link utilization for the modified network topology;

(7g) restoring the weight and marking ~~the~~said one of said each link having the maximum link cost when at least one of:

the network cost for operating the modified network topology is greater than or equal to the network cost for operating the current network topology; and

the standard deviation of link utilization for the current topology is less than the standard deviation of link utilization for the modified topology; and

(8h) repeating sub-steps (4d) through (7g) until said each ~~of the~~ links in the network topology is marked.

13. (Currently Amended) A method for increasing the capability of a network topology model as defined in Claim 12, wherein:

said sub-step (3e) in step (b) further comprises determining survivability characteristics of the current network topology;

said sub-step (5e) in step (b) further comprises determining the survivability characteristics of the modified network topology; and

said sub-step (7g) in step (b) for restoring the weight and marking the link having the maximum link cost is performed when at least one of:

the survivability characteristics of the modified network has deteriorated in comparison to the survivability characteristics of the current network topology;

the network cost for operating the modified network topology is greater than or equal to the network cost for operating the current network topology; and

the standard deviation of link utilization for the current topology is less than the standard deviation of link utilization for the modified topology.

14. (Currently Amended) A method for increasing the capability of a network topology model as defined in Claim 3, wherein step (b) comprises the sub-steps of:

(1a) calculating a standard deviation of link utilization for the current network topology;

(2b) unmarking ~~all of the~~ each links in the network topology;

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- (3e) calculating a network cost for operating the current network topology based upon a link cost associated with said each link;
- (4d) incrementing the weight of one of said each~~the unmarked~~ link in the current network topology having the maximum cost to modify the network topology;
- (5e) calculating a network cost for operating the modified network topology;
- (6f) calculating a standard deviation of link utilization for the modified network topology;
- (7g) restoring the weight and marking ~~the~~said one of said each link having the maximum link cost when at least one of:
 - the network cost for operating the modified network topology is greater than or equal to the network cost for operating the current network topology; and
 - the standard deviation of link utilization for the current network topology is less than the standard deviation of link utilization for the modified network topology; and
- (8h) repeating sub-steps (3e) through (7g) until said each ~~of the~~ links in the network topology is marked.

15. (Currently Amended) A method for increasing the capability of a network topology model as defined in Claim 14, wherein:

- said sub-step (3e) in step (b) further comprises determining survivability characteristics of the current network topology;
- said sub-step (5e) in step (b) further comprises determining the survivability characteristics of the modified network topology; and
- said sub-step (7g) in step (b) for restoring the weight and marking the link having the maximum link cost is performed when at least one of:
 - the survivability characteristics of the modified network has deteriorated in comparison to the survivability characteristics of the current network topology;
 - the network cost for operating the modified network topology is greater than or equal to the network cost for operating the current network topology; and
 - the standard deviation of link utilization for the current network topology is less than the standard deviation of link utilization for the modified network topology.

16. (Currently Amended) A method of adjusting link weights as defined in Claim 14, further comprising the sub-step of step (b):

(9i) increasing the link capacity such that the link utilization is no longer higher than a specified threshold.

17. (Original) A method for adding new links to a network topology model having a plurality of nodes connected by existing links to achieve protection against single node failures for Open Shortest Path First (OSPF) and Multiprotocol Label Switching (MPLS) based local recovery, said method comprising the steps of:

- (a) failing one of the plurality of nodes in the network topology;
- (b) calculating a first number of disconnected node pairs;
- (c) selecting a pair of nodes which are neighbors to the failed node;
- (d) adding a new link between the pair of nodes;
- (e) calculating a second number of disconnected node pairs;
- (f) retaining the new link and setting the first number equal to the second number when the second number is less than the first number;
- (g) repeating steps (c) through (f) for randomly selected combination of the pair of nodes until the first number equals zero;
- (h) repeating steps (a) through (g) for each of the plurality of nodes in the network topology as modified by the addition of the retained links;
- (i) removing one of the plurality of retained links in the modified network topology;
- (j) restoring the removed link when the removal causes any node pair to become disconnected for any single node failure; and
- (k) repeating steps (i) through (k) for each of the plurality of retained new links in the modified network topology.

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18. (Currently Amended) A method for adjusting link weights for a network topology model having a plurality of nodes connected by links to reduce the cost of network operation, said method comprising the steps of:

- (a) unmarking each link in the network topology;
- (b) calculating a network cost for operating the current network topology based upon a link cost associated with said each link;
- (c) incrementing the weight of one of said each ~~the unmarked~~ link in the current network topology having the maximum link cost to modify the network topology;
- (d) calculating a network cost for operating the modified network topology;
- (e) restoring the weight and marking ~~the~~ said one of said each link having the maximum link cost when the network cost for operating the modified network topology is greater than or equal to the network cost for operating the current network topology; and
- (f) repeating steps (b) through (e) until said each ~~of the~~ links in the network topology is marked;

wherein:

step (b) further comprises determining survivability characteristics of the current network topology;

step (d) further comprises determining the survivability characteristics of the modified network topology; and

step (e) for restoring the weight and marking the link having the maximum link cost is performed when at least one of:

the survivability characteristics of the modified network has deteriorated in comparison to the survivability characteristics of the current network topology; and

the network cost for operating the modified network topology is greater than or equal to the network cost for operating the current network topology.

19. (Cancelled).

20. (Cancelled).

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21. (Original) A method of adjusting link weights in a network topology model having a plurality of nodes connected by links to reduce an imbalance in link utilizations, said method comprising the steps of:

- (a) unmarking ~~all of the~~ each links in the network topology;
- (b) calculating a standard deviation of link utilization for the current network topology;
- (c) incrementing the weight of one of said each~~the unmarked~~ link in the current network topology having the maximum utilization to modify the network topology;
- (d) calculating a standard deviation of link utilization for the modified network topology;
- (e) restoring the weight and marking ~~the~~said one of said each link having the maximum utilization when the standard deviation of link utilization for the current topology is less than the standard deviation of link utilization for the modified topology; and
- (f) repeating steps (b) through (e) until said each ~~of the~~ links in the network topology is marked.

22. (Currently Amended) A method for increasing the capability of a network topology model as defined in Claim 21, wherein:

~~said sub-step (b) in step (b)~~ further comprises determining survivability characteristics of the current network topology;

~~said sub-step (d) in step (b)~~ further comprises determining the survivability characteristics of the modified network topology; and

~~said sub-step (eg) in step (b)~~ for restoring the weight and marking the link having the maximum link cost is performed when at least one of:

the survivability characteristics of the modified network has deteriorated in comparison to the survivability characteristics of the current network topology; and

the standard deviation of link utilization for the current topology is less than the standard deviation of link utilization for the modified topology.

23. (Original) A method of adjusting link weights in a network topology model having a plurality of nodes connected by links to reduce an imbalance in link utilizations without deteriorating the cost of network operation, said method comprising the steps of:

- (a) calculating a network cost for operating the current network topology based upon a link cost associated with each link;
- (b) unmarking said each ~~all of the~~ links in the network topology;
- (c) calculating a standard deviation of link utilization for the current topology;
- (d) incrementing the weight of one of said each ~~the unmarked~~ link in the current network topology having the maximum utilization to modify the network topology;
- (e) calculating a network cost for operating the modified network topology;
- (f) calculating a standard deviation of link utilization for the modified network topology;
- (g) restoring the weight and marking ~~the~~ said one of said each link having the maximum link cost when at least one of:
 - the network cost for operating the modified network topology is greater than or equal to the network cost for operating the current network topology; and
 - the standard deviation of link utilization for the current topology is less than the standard deviation of link utilization for the modified topology; and
- (h) repeating steps (d) through (g) until said each ~~of the~~ links in the network topology is marked.

24. (Currently Amended) A method for increasing the capability of a network topology model as defined in Claim 23, wherein:

- ~~said sub-step (c) in step (b)~~ further comprises determining survivability characteristics of the current network topology;
- ~~said sub-step (e) in step (b)~~ further comprises determining the survivability characteristics of the modified network topology; and

~~said sub-step (g) in step (b)~~ for restoring the weight and marking the link having the maximum link cost is performed when at least one of:

the survivability characteristics of the modified network has deteriorated in comparison to the survivability characteristics of the current network topology;

the network cost for operating the modified network topology is greater than or equal to the network cost for operating the current network topology; and

the standard deviation of link utilization for the current topology is less than the standard deviation of link utilization for the modified topology.

25. (Original) A method of adjusting link weights in a network topology model having a plurality of nodes connected by links to reduce the cost of network operation without increasing an imbalance in link utilizations, said method comprising the steps of:

(a) calculating a standard deviation of link utilization for the current network topology;

(b) unmarking ~~all of the~~ each links in the network topology;

(c) calculating a network cost for operating the current network topology based upon a link cost associated with said each link;

(d) incrementing the weight of the unmarked link in the current network topology having the maximum cost to modify the network topology;

(e) calculating a network cost for operating the modified network topology;

(f) calculating a standard deviation of link utilization for the modified network topology;

(g) restoring the weight and marking ~~the~~ said one of said each link having the maximum link cost when at least one of:

the network cost for operating the modified network topology is greater than or equal to the network cost for operating the current network topology; and

the standard deviation of link utilization for the current network topology is less than the standard deviation of link utilization for the modified network topology; and

(h) repeating steps (c) through (g) until said ~~each of the~~ links in the network topology is marked.

26. (Currently Amended) A method for increasing the capability of a network topology model as defined in Claim 25, wherein:

~~said sub-step (c) in step (b)~~ further comprises determining survivability characteristics of the current network topology;

~~said sub-step (e) in step (b)~~ further comprises determining the survivability characteristics of the modified network topology; and

~~said sub-step (g) in step (b)~~ for restoring the weight and marking the link having the maximum link cost is performed when at least one of:

the survivability characteristics of the modified network has deteriorated in comparison to the survivability characteristics of the current network topology;

the network cost for operating the modified network topology is greater than or equal to the network cost for operating the current network topology; and

the standard deviation of link utilization for the current network topology is less than the standard deviation of link utilization for the modified network topology.

27. (Original) A method of adjusting link weights as defined in Claim 25, further comprising the step of:

(i) increasing the link capacity such that the link utilization is no longer higher than a specified threshold.

28. (Currently Amended) A computer-readable storage medium comprising instructions
~~An article of manufacture~~ for increasing the capability of a network topology model having a plurality of nodes connected by existing links to maintain service continuity in the presence of faults that, when executed by a processor, causes the processor to: 7

~~said article comprising:~~

~~a machine-readable medium containing one or more programs which when executed implement the steps of:~~

(a) adding new links to the network topology model to protect against single node failures; and

(b) adjusting link weights for the network topology model to reduce at least one of a cost of network operation, and an imbalance in link utilizations;

wherein step (a) comprises the sub-steps of:

- (1) failing one of the plurality of nodes in the network topology;
- (2) calculating a first number of disconnected node pairs;
- (3) selecting a pair of nodes which are neighbors to the failed node;
- (4) adding a new link between the pair of nodes;
- (5) calculating a second number of disconnected node pairs;
- (6) retaining the new link and setting the first number equal to the second number when the second number is less than the first number;
- (7) repeating sub-steps (3) through (6) for randomly selected combinations of pairs of neighbor nodes until the first number equals zero;
- (8) repeating sub-steps (1) through (7) for each of the plurality of nodes in the network topology as modified by the addition of the retained links;
- (9) removing one of the plurality of retained links in the modified network topology;
- (10) restoring the removed link when the removal causes any node pair to become disconnected for any single node failure; and
- (11) repeating sub-steps (9) through (11) for each of the plurality of retained new links in the modified network topology.

29. (Currently Amended) A computer-readable storage medium as defined in Claim 28, wherein the medium further comprises instructions, that when executed by the processor, causes the processor ~~said machine-readable medium is configured to~~ reduce said imbalance in link utilizations without deteriorating said cost of network operation.

30. (Currently Amended) A computer-readable storage medium as defined in Claim 28, wherein the medium further comprises instructions, that when executed by the processor, causes the processor ~~said machine-readable medium is configured to~~

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reduce said cost of network operation without increasing said imbalance in link utilizations.

31. (Currently Amended) A computer-readable storage medium as defined in Claim 28, wherein the medium further comprises instructions, that when executed by the processor, causes the processor ~~said machine-readable medium is configured~~ to reduce said cost of network operation without increasing said imbalance in link utilizations while keeping the utilization for each link below a specific threshold.

32. (Currently Amended) A computer-readable storage medium as defined in Claim 28, wherein the medium further comprises instructions, that when executed by the processor, causes the processor ~~said machine-readable medium is configured~~ to ~~perform the additional step of:~~

(c) ~~adding~~ links to the network topology model to reduce the cost of network operation.

33. (Currently Amended) An apparatus for increasing the capability of a network topology model having a plurality of nodes connected by existing links to maintain service continuity in the presence of faults, said apparatus comprising:

a network topology analyzing unit configured to:

(a) add new links to the network topology model to protect against single node failures; and

(b) adjust link weights for the network topology model to reduce at least one of a cost of network operation, and an imbalance in link utilizations;

wherein step (a) comprises the sub-steps of:

(1) failing one of the plurality of nodes in the network topology;

(2) calculating a first number of disconnected node pairs;

(3) selecting a pair of nodes which are neighbors to the failed node;

(4) adding a new link between the pair of nodes;

(5) calculating a second number of disconnected node pairs;

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(6) retaining the new link and setting the first number equal to the second number when the second number is less than the first number;

(7) repeating sub-steps (3) through (6) for randomly selected combinations of pairs of neighbor nodes until the first number equals zero;

(8) repeating sub-steps (1) through (7) for each of the plurality of nodes in the network topology as modified by the addition of the retained links;

(9) removing one of the plurality of retained links in the modified network topology;

(10) restoring the removed link when the removal causes any node pair to become disconnected for any single node failure; and

(11) repeating sub-steps (9) through (11) for each of the plurality of retained new links in the modified network topology.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to DADY CHERY whose telephone number is (571)270-1207. The examiner can normally be reached on Monday - Thursday 8 am - 4 pm EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Huy D. VU can be reached on 571-272-3155. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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